Aviation Safety Locus of Control

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ABSTRACT

A scale was developed to assess pilots' locus of control with respect to aviation safety issues. Based upon an existing Safety Locus of Control scale (Jones and Wuebker, 1985), this scale consisted of 24 items. Participants responded to the items using a 5-point Likert scale. The scale was administered over the internet through a government-sponsored web site, and approximately 480 pilots completed the scale. Two subscales were created, assessing internality and externality. These subscales exhibited acceptable internal consistency, and were negatively correlated ($r = -.419$, $p < .001$). Correlation of the subscales with a measure of resignation supported the construct validity of the scale. External validity of the scale was assessed through correlation with an index of involvement in hazardous aviation events. Pilots who were more internal in their orientation were found to be at lesser risk of involvement in a hazardous aviation event than pilots with an external orientation. Consistent with previous research, pilots exhibited substantially higher internal orientation than external orientation on the new scale. It was also found that internality increased as a function of chronological age, but not as a function of increased flight time. Implications of these findings and suggested applications of the new scale are discussed, and suggestions for additional research are given.

Author Note

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Aviation Safety Locus of Control

Locus of control refers to the degree to which a person perceives that the outcomes of the situations they experience are under their personal control. Individuals with an internal locus of control orientation perceive that they can exert control over the outcome of the situation, while individuals with an external locus of control attribute outcomes to external factors, such as luck or the actions of other persons. Since Rotter (1966) first proposed this construct, it has been widely used an a variety of settings. (For a review of that research, see Lefcourt, 1982; Robinson, Shaver, and Wrightsman, 1990.)

Wichman and Ball (1983) administered the Rotter Internal-External Locus of Control (LOC) scale to 200 general aviation pilots. In comparison to Rotter's 1966 sample, these pilots were significantly more internal. Internal locus of control and age were also found to significantly predict attendance at safety clinics. Pilots with higher internal scores were more likely to attend – indicative of safety orientation. Wichman and Ball suggest that for pilots who are more internal in locus of control, "…their way of handling dangers is not just to make light of them, but to actively do something about reducing the dangers." (p. 509)

In addition to the original Rotter scale which assessed general LOC, scales have also been developed to assess the degree of perceived control over specific issues. For example, specialized LOC scales have been developed by Regis (1990) and by Wallston, Kaplan, and Maides (1976) to assess health locus of control. Jones and Wuebker (1985) described the development and validation of the Safety Locus of Control scale, derived from the Rotter locus of control scale, to predict employees' accident and injuries. They found that participants in the lower accident risk groups were significantly more internal than participants in the high risk groups. They note, however, that it was not possible to determine whether the individuals were higher on internality before their accidents, or became higher as a result of their accidents. Nevertheless, they conclude that the findings of their study strongly suggest that the "construct of safety locus of control can be assessed and used to predict behavior." (p. 160)

The Safety Locus of Control scale was also used by Jones and Wuebker (1993) in a study of accidents among 283 hospital workers. They report that employees with more internal safety attitudes were significantly less likely to experience occupational accidents, and were less likely to have severe and costly accidents, compared to employees with more external attitudes.

In this study, I created an Aviation Safety Locus of Control scale that would specifically address the construct of internality-externality among pilots as it pertains to issues relevant to aviation safety. I hypothesized that pilots who were more internal on this scale would be at lesser risk of accident involvement.

Method

Participants

Participants were recruited from visitors to a web site sponsored by the Federal Aviation Administration. Visitors to the site were invited to participate in this and several other research activities. Over a period of approximately 6 months (ending May

1, 2001) 490 pilots completed all 24 items of the scale. Demographic characteristics of the sample are given in Table 1.

Instrument Development and Data Collection

The 24 items of the Safety Locus of Control (Jones & Wuebker, 1985) were rewritten, so as to place them in an aviation context The items are listed in Table 2. Table 2 also provides the scoring key for Internality and Externality used in the original Safety Locus of Control scale, and an a priori scoring key developed through inspection of the items by myself and another experienced aviation psychologist.

Instructions for completing the scale were published on the web site, along with an assurance of anonymity for participants. Each of the items comprising the scale appeared one-at-a-time on the screen. Participants responded to the items using a 5-point Likert scale which ranged from Strongly Agree (1) to Strongly Disagree (5). Participants' responses were automatically recorded and saved in a database on the web server computer.

Results and Discussion

Creating Internality and Externality Scores

Two approaches to scoring the scale were used, conforming to the methods previously reported in the literature on LOC. First, separate Internality and Externality scores were generated from the item responses, using the a priori key given in Table 2. This scoring approach has been used by other studies, and conforms to the theoretical position that internality and externality are not opposite ends of a single continuum, but represent distinct, separate constructs. A factor analysis of the item response data supported this position, indicating that a two factor solution described the data better than a single factor solution. The scaling of the items was reversed, so that higher scores indicated agreement with the items. This was done by subtracting each item response from 6. (i.e., new response = 6 – old response).

Inspection of the internal consistency indices (Coefficient Alpha) for the scales suggested that reliability would be maximized by omitting certain of the items, leading to the formation of two scales (Internal and External), each with 10 items. These are identified in the Empirical Scale column in Table 2.

Because the original Rotter scale, along with some of the subsequently developed variants, used a single score to indicate degree of Internality and Externality, that scoring method was also evaluated here. Items identified as externally oriented were left in the original response orientation (i.e., Strongly Agree = 1; Strongly Disagree = 5), while items identified as internally oriented were reversed (i.e., Strongly Agree = 5; Strongly Disagree = 1). This resulted in a score with a possible range of 20 (most external) to 100 (most internal). The same 20 items used in the separate internality and externality subscales were used to generate this single index. Preliminary analysis of this scale indicated that although it had a somewhat greater coefficient alpha (.754) than the individual subscales, the other results were approximately equivalent. Therefore, only the results for the individual Internal and External subscales will be presented. Readers are directed to Montag and Comrey (1987), and Collins (1974) for a discussion and review of the question of multidimensionality of the LOC construct.

Evaluation of the Scales

Coefficient Alpha for the Internal and External subscales were, 0.69 and 0.63, respectively, based on a sample of approximately 484 cases. These are somewhat less than the Spearman-Brown split-half reliability coefficient (.85) reported by Jones and Wuebker (1985) for the original safety locus of control instrument. However, the results are similar to that obtained for other, shortened LOC scales. For example, Regis (1990) reported coefficient alphas ranging from .51 to .59 for his 18-item Health Locus of Control scale, while Wallston, Kaplan and Maides (1976), reported alphas of .54 to .71 for their 11-item scale. Using a 9-item abbreviated version of the original Rotter scale, Valecha & Ostrom, (1973) obtained an alpha coefficient equal to .64.

The correlation between the Internal and External subscales was –0.419 ($N = 477$, $p < .001$). Comparison of the means, using the SPSS™ paired-sample t-test, demonstrated that pilots in this sample were significantly higher ($t = 69.1$, $df = 476$, $p < .001$) on the Internal subscale ($M = 38.8$, $SD = 4.34$) than on the External subscale ($M = 17.2$, $SD = 3.79$).

Wichman and Ball (1983) questioned whether pilots become more internal as a consequence of experience. To address that question, I correlated the Internal and External subscale scores with age and total flight time. The correlations between age and the Internal and External subscale scores were .237 and -.213, respectively. Both these correlations are statistically significant ($p < .05$). The correlations between total flight time and the Internal and External subscale scores were -.050 and -.012, respectively. Neither of these correlations are statistically significant. These results demonstrate that pilots become more internal and less external as they grow older. However, increasing flight time has no impact on internal or external orientation.

Construct Validity

To assess the construct validity of the Aviation Safety Locus of Control scale, I examined its relationship to the Resignation scale from the Hazardous Attitudes Inventory. The Hazardous Attitudes Inventory (Berlin & Holmes, 1981; Lester & Connolly, 1987) was developed as a pedagogic device to assist pilots in learning about the factors that influence decision-making. The inventory consists of 10 scenarios depicting hazardous aviation situations. Each scenario has five alternative explanations of why a pilot might have gotten into such a situation or made the decisions depicted. Pilots are expected to choose the alternative explanation that best describes what they would have done. Each of the five alternatives is keyed to one of five hazardous attitudes, and an ipsative scoring procedure is used to generate scores for each of the five hazardous attitudes. The Resignation score indicates the degree to which the pilot chooses alternatives that indicate a feeling of powerlessness to control the events. Therefore, I expected that higher scores on the Resignation scale would be associated with higher scores on the Externality Scale and lower scores on the Internality scale.

The correlations between the Resignation score and the Internal and External subscale scores were .010 (non significant) and .157 ($p < .05$), respectively. The significant correlation between Resignation and the External subscale score is in the expected direction, indicating that pilots who had a more external orientation also had higher scores on the Resignation scale from the Hazardous Attitudes Inventory. This supports, albeit weakly, the construct validity of the new LOC scale.

External Validity

The external validity of the Aviation Safety Locus of Control scale was evaluated with respect to a Hazardous Events Scale (HES; Hunter, 1995). This scale assesses the number of instances in which a pilot has been involved in an event which could have easily become an accident, had circumstances been slightly different. For example, this scale includes items which assess the number of times the pilot has run low on fuel or inadvertently entered adverse weather conditions. This scale is proposed as a surrogate for the preferred external criterion of involvement aircraft accidents because the low incidence of accidents makes the use of that criterion problematic.

Of the 490 pilots with Aviation Safety LOC scores, there were 176 who had also completed the HES. The mean score for the HES equals 2.99, and the standard deviation equals 3.36. The correlations between the HES and the Internal and External subscale scores were –0.205 ($p = .007$) and 0.077 (non significant), respectively. The significant correlation between the Internality score and the HES is in the expected direction, indicating that pilots with higher internal orientation experience fewer hazardous experiences. There was no apparent relationship between the externality score and hazardous experiences.

A potential problem in the interpretation of this result is the non-normal distribution of the HES score. It exhibits a very skewed distribution, with most values equal to one or zero. A logarithmic transform was used which produced an approximately normal distribution of scores. However, this attenuates somewhat the correlation between the Aviation Safety LOC scores and the criterion, and constitutes an unsatisfactory solution to the continuing problem of research with infrequent events.

Conclusions

A new Aviation Safety Locus of Control scale was constructed based on a measure of locus of control used to assess industrial worker safety. The items comprising this new scale were set in aviation terms and administered over the internet. From that scale, two subscales assessing internality and externality of pilots were derived. These internality and externality subscales exhibited acceptable internal consistency for a large sample of pilots. The relationship of scores on the two subscales to each other and to other measures was in accordance with expectations.

Consistent with previous research (Wichman and Ball, 1983), pilots exhibited substantially higher internal orientation than external orientation on the new scale. The comparison of the Aviation Safety LOC scale with the Resignation score from the Hazardous Attitudes Inventory supports the construct validity. In assessing the external validity of the Aviation Safety LOC, I found that pilots who experienced more hazardous aviation events (that might easily have developed into accidents) had a lower internal orientation. Readers should note, however, that although the results are statistically significant, and interesting from a theoretical perspective, the magnitude of this effect is very small, accounting for only 4% of the variance in the external criterion.

The initial results are promising, however additional research is required to improve the internal consistency of the Aviation Safety LOC scales and to further assess the convergent and divergent construct validity. The finding that pilots become more internally oriented as they grow older, but not as they become more experienced, is also intriguing. This implies that the mere accumulation of flight hours is not sufficient to bring about a change in the pilot's orientation. Rather, it is their total life experience that leads to such a change. This is consistent with the general view of LOC as a stable personality variable. Clearly, if such is the case, then attempting to train pilots to become more internal (and hence, safer) might be exceptionally difficult; although, some authors (c.f., Andrisani & Nestel, 1976; Lefcourt, 1982) have suggested that personal experiences, directed cultural teaching, and therapeutic interventions can influence the development of internality.

In its present form, the scale might be employed as a self-awareness exercise for pilots wishing to explore potential aspects of their personality that could place them at greater risk for accident involvement. It may also prove useful as a covariate in research investigating the impact of other factors on accident involvement. Although the obtained effect size is small, every reduction in unexplained variance helps us refine our future studies as we slowly chip away at this problem.

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Table 1.
Demographic Characteristics of Sample

Certificate		
Student (16%)[1]	24%	
Private (42%)[1]	52%	
Commercial (20%)[1]	18%	
Airline Transport (22%)[1]	4%	

Instrument Rating		
Yes	39%	
No	61%	

	M	SD
Age	46	12.2
Total Flight Time	918	2065
Recent Flight Time	74	101

NOTE 1: Proportion of certificate holders in the total US pilot population. Source: FAA 1999 Annual Report on Aviation System Indicators.

Table 2.
Aviation Safety Locus of Control Items and Scoring Keys

Item Number	Kamp Key	a priori Key	Empirical Key	Item
1	I	I	I	If pilots follow all the rules and regulations, they can avoid many aviation accidents.
2	E	E	E	Accidents are usually caused by unsafe equipment and poor safety regulations.
3	X	I	I	Pilots should lose their license if they periodically neglect to use safety devices (for example, seat belts, checklists, etc.) that are required by regulation.
4	I	I	I	Accidents and injuries occur because pilots do not take enough interest in safety.
5	E	E	E	Avoiding accidents is a matter of luck.
6	X	I	I	Most accidents and incidents can be avoided if pilots use proper procedures.
7	E	E	E	Most accidents and injuries cannot be avoided.
8	E	E	X	It is the FAA's responsibility to prevent all aviation accidents.
9	X	I	X	Most pilots never think about safety during their flights.
10	I	I	I	Most accidents are due to pilot carelessness.
11	E	E	X	There are so many dangers in this world that you never know how or when you might be in an accident.
12	X	E	E	Most pilots will be involved in accidents or incidents which result in aircraft damage or personal injury.
13	X	I	I	Pilots should be fined if they have an accident or incident while "horsing around".
14	I	I	I	Most accidents that result in injuries are largely preventable.
15	X	E	E	Pilots can do very little to avoid minor incidents while working.
16	E	E	X	No matter how hard pilots try to prevent them, there will always be accidents.
17	E	E	E	Whether people get injured or not is a matter of fate, chance, or luck.
18	I	I	I	Pilots' accidents and injuries result from the mistakes they make.

19	E	E	E	Most accidents can be blamed on poor FAA oversight.
20	E	E	E	Most injuries are caused by accidental happenings outside people's control.
21	I	I	I	People can avoid getting injured if they are careful and aware of potential dangers.
22	X	E	E	It is more important to complete a flight than to follow a safety precaution that costs more time.
23	I	I	I	There is a direct connection between how careful pilots are and the number of accidents they have.
24	E	E	E	Most accidents are unavoidable.

Note: X indicates items that were not scored.